

Computer Science

Computer science is a broad field that encompasses theory, mathematical activities such as design and analysis of algorithms, performance studies of systems and their components, and the estimation of reliability and availability of systems by probabilistic techniques. The field encompasses the study of computers, their design, and their uses for computation, data processing, and systems control including design and development of computer hardware and software, and programming.

In the past, the development and advance of computational engines (and the development of computer science as a field) was largely driven by the needs of users in the scientific arena. Not surprisingly, the early development of supercomputers was largely driven by the nuclear weapons program. However, in the past decade or so, the advance of computing has been driven by different demographics in the financial and gaming industries.

There are essentially three major elements within computer science: (1) architecture, which includes all levels of hardware design and the integration of hardware and software components to create a complete computer system; (2) the software, or computer programs that cause the computer to carry out tasks, which broadly includes software design and engineering, programming language, operating systems, information systems and databases, artificial intelligence, computer graphics, and visualization; (3) theory, which includes computational methods and numerical analysis of both data structures and algorithms.

Edsger Dijkstra, a Dutch computer scientist who won the Turing Award in 1972, perhaps described the field best by saying, "Computer science is no more about computers than astronomy is about telescopes." Computer science is still very much an evolving field, and the subsections of this document speak to the rich technical diversity in the field today. These brief articles outline the state-of-the-art in computer science research and development at Los Alamos National Laboratory at the present time.

The section on “computational architecture exploration” is focused on techniques for enhancing application throughput on the latest computing systems as well as the exploration of new and emerging technologies that will comprise tomorrow’s supercomputing systems for applications of interest. Not surprisingly, this involves hardware and computing technology and software.

The section on “libraries and tools” is centered on software tools for the application developer, and software engineering techniques that enhance the agility of computational physics software—a necessity with today’s rapid changes in computing technology.

The section on “theoretical and applied foundations of data and management” speaks to theory and algorithmic advances that couple two seemingly disparate applications—speech recognition and image processing for the nuclear weapons program. The article scratches the surface of information sciences and is an indicator of the potential energy behind the emerging information sciences thrust at Los Alamos.

The “advanced visualization and data management” section is also strongly related to information sciences, and is centered on the advanced development, tools, and infrastructure geared toward the extraction of knowledge—not simply information—from vast arrays of data produced by simulation tools, which generate volumes of data akin to the entire Library of Congress in a single simulation.

Finally, the last section titled “system software” is about the software at the level of the “metal” in a computer—the operating system and kernel that lie just above the computer hardware and below all of the applications that run on it.